

THE
Indian Tea Association.

SCIENTIFIC DEPARTMENT

QUARTERLY JOURNAL.

PART II.

1929.

Calcutta:
PRINTED AT THE CATHOLIC ORPHAN PRESS,
3 & 4, PORTUGUESE CHURCH STREET.

1929.

CONTENTS

	PAGE.
A TIGER BEETLE	45
HUMIDIFICATION IN TEA FACTORIES ...	51
THE TOCKLAI CLEARANCE	61
VEGETABLE PARASITES OF THE TEA PLANT ...	68
TEA IN NORTH-EAST INDIA	76

A TIGER BEETLE

(*Neocollyris crassicornis*, Dejean)

BORING INTO TEA STEMS IN N. E. INDIA.

BY

E. A. ANDREWS

In March of last year, and again in March of this year, specimens of a borer in tea stems were submitted, by Mr. H. R. Mortimer, of the New Dooars Tea Co., which appeared to him to differ in behaviour and characteristics from the usual borer in tea. This, on examination, has been found to be the grub of a tiger beetle, *Neocollyris crassicornis*, Dejean, a species widely spread over the greater part of Continental India, and which, though previously recorded from both Bengal and Assam, has never before been recorded as a pest of tea.

Tiger beetles, placed by entomologists in the family Cicindelidae, are essentially predaceous insects, of the most voracious description. Imms* remarks, "The members of this family "are among the most voracious and fierce of all insects, particularly in the larval stages and, on account of these habits, they have "earned the popular designation of tiger beetles." In all, the family contains some 1,800 species, about half of which belong to the genus *Cicindela*, which, in the young stages, live in burrows in the ground, and in the adult stage may often be seen, in this part of the world, running about on river banks in search of prey, conspicuous, not so much on account of their often brilliant colours, as on account of the erratic manner in which they dart, with extreme rapidity and in the most unexpected directions, over the surface of the sand. This family of insects would, therefore, be one in which one would hardly expect to find a pest of cultivated plants, yet for some years past it has been known that cer-

* "Textbook of Entomology," 1925.

tain members of the family, arboreal in habit when adult, pass the larval stage in burrows in the stems of plants. The available records are not many. The Imperial Entomologist records* that the larva of a tiger beetle, probably referable to the species *Neocollyris bonelli*, Guérin, bores into twigs of *Zizyphus jujuba* at Pusa in Behar, and an account of the life-history of this species, and of two others with similar habits, was published † by van Leeuwen in 1910. Koningsberger, in 1905, published ‡ a notice of a species, *Neocollyris emarginata*, Dejean, which burrows in the twigs of coffee shrubs in Java, and a species which has not yet been identified has on several occasions been recorded as attacking both tea and coffee in South India, but is apparently rare, and little is known about it.

The damage done by the tiger beetle to tea in North East India is distinctive, and consists of a straight tunnel, about an inch long by $1/8$ inch diameter, excavated in the pith of the stem, and, at one end, opening to the exterior of the stem in the form of a circular orifice $1/8$ to $3/16$ inch diameter. This orifice is distinguished from the emergence hole of the red borer by the fact that the edges of the orifice are countersunk, as if it had been turned out with a rose bit to admit the head of a screw, while at the inner edge of the bevel so formed is a projecting rim, or collar, made of brass, cemented into a dark brown felted mass, forming, as it were, a wall to the orifice.

The larva of the beetle lines in the burrow, with the head towards the hole. When almost full-grown, it is about $5/8$ inch long. The body is soft, fleshy and pinkish-coloured, very similar in nature to that of the caterpillar of the red borer *Zeuzera coffeae* Nietner, and if the body be only partly exposed in a casual examination, the insect may be mistaken for the latter. On cutting away further, however, it will be found, first, that the burrow is not much more than an inch long, whereas the red borer bores right along the stem; second, that the insect is of an entirely

* The Planter's Chronicle, XII, 1917.

† "Tijdschrift voor Entomologie."

‡ "Mededeelingenu it Lands Plantentuin," XLIV.

different type. The body itself is narrow at the front, gradually thickening to the fifth segment of the abdomen, which has two pronounced humps on its back, each provided with hooks and apparently designed to assist the larva in obtaining a purchase in the burrow. Along the sides and under-surface of the body small protuberances, apparently developed for the same object, may also be seen. The posterior part of the abdomen tapers very gradually, but remains distinctly thicker than the front portion. This latter merges, forward, into the thorax. The hind and middle segment of this part of the body are very narrow, but normal. The first segment, however, is bent over almost at right angles so that the upper side extends accross the axis of the insect's body. This upper side is strongly chitinised, and the large, powerful, shovel-shaped head, broad from side to side and flattened from top to bottom, is set on at right angles to the first thoracic segment, projecting forward, so that it appears to be attached to the underside of the front end of the body. The fang-like jaws are situated on the upper surface of the front of the head. This construction is adapted to the insect's habit of lying in the burrow with the head filling the mouth of the orifice, in which position it is ready to catch the ants, aphids, or other insects, on which it feeds, as they run by. There are three pairs of small jointed legs on the three thoracic segments.

Pupation appears to take place in the burrow, though it has not been observed, nor has the pupal-skin been found, and adult insects are to be found in the burrows too, head towards the orifice. The beetle is about $5/8$ of an inch long, and slender. In colour it is generally blue or green, with the "steely" sheen so common to brightly coloured hard-bodied beetles. Occasionally the colour takes on a violet tinge, and it may be almost black, but the specimens so far seen have been blue or green. Looked at from above, the body is seen to be distinctly divided into three parts. Forward is a large, mobile head, carrying a very large pair of compound eyes and a long pair of antennæ, thin towards the base, thicker towards the apex, and a dead sort

of brown in colour. With a glass it can be seen that the area between the eyes is depressed, with a distinct groove at each side, and convex in the centre. Behind the head is the first segment of the thorax, shaped more or less like a bottle or flask with the head of the insect attached to the neck, and with a sort of foot to the flask to give it a flat base. Under a glass it can be seen that this part of the body is covered with fine transverse grooves above, and is somewhat coarsely punctured below. Behind this the upper surface of the body is covered by the wing-covers which are much punctured, in an irregular honeycomb manner, from the front to the middle of the wing covers, but with punctures, elongated along the length of the body, in the hinder half. The legs are long and slender, the first long joint of each leg reddish, the remainder dark in colour.

The adults emerge in April and May. They appear to remain in the burrow for some time before emergence, but whether during that time they feed or not we have not, so far, been able to ascertain.

In the Tocklai collection is a specimen of this beetle, caught by Mr. Antram on "missi" (*Maesa indica*) in Silchar in June, 1907. Antram's notes also state that the beetle comes to light, but there are no specimens caught at light. Another specimen, which does not appear to be identical (distinction between species is difficult in this group), was caught at Borbhetta, on tea, in September, 1915, by the entomological field assistant, but has not, so far, been found in the larval stage. These are the only specimens in the collection, and are evidence of the infrequency with which the insect is found on tea. Mr. Mortimer states that he found it in nurseries, in young tea, and in old tea, and that affected places were more than a mile apart. Moreover, judging merely by the specimens received, the beetles were present in large numbers. In several stems, in fact, the holes were as close together as they could well be without the insects having to share a burrow.

The question arises as to what should have caused this sudden attack on the part of an insect, sufficiently common to have been known to entomologists for years, which has never during all those years (the Centenary of tea will be on us before we know where we are) done damage sufficient to be recorded. It has now occurred for two years in succession.

One feature of these insects, so far as present knowledge goes, is that, though they may occur at widely separated places, their distribution is local, that is, they may be in numbers at one spot, and rare at a spot not far away. This would appear to indicate that a close approximation to a certain set of conditions is essential to their well-being. It may therefore be assumed that, these conditions having failed them in their usual habitat, a migration took place, and they came to the tea. There, for two years, they have found a favourable set of conditions. Two conditions we know to be essential. First, young, "pithy" stems, for the insects are apparently unable to bore through hard wood. Second, a plentiful supply of the insects on which they feed, on the bushes in which they have their burrows, for the larvae are unable to go abroad to forage for food. With regard to the first condition, it will readily be seen that every inch (or inch and a half, at any rate) of young wood left on the bushes at the time of pruning offers a home to one of these insects, and that unpruned tea offers most harbourage of all. As there would appear to be only the one generation in the year, a recognition of this fact might help considerably in control. With regard to food supply, it will be necessary to make observations on the food of the insects on the spot before much can be said. Fowler states* that the food of *Neocollyris emarginata* consists of aphides, small ants, etc., which approach the entrance to the burrow. The insects we have had in captivity have been tried with all kinds of small insects, but so far have not been observed to take even ants. As most of them were practically full-grown when received, it is possible that feeding had stopped.†

*F.B.I., Coleoptera, General Introduction & Cicindelidae & Paussidae, page 230.

† Since the above was written the insects have been observed to take both ants and tea aphids.

The question of the possible status of this insect as a pest or otherwise is of interest. There is no doubt that by boring into the tea stems damage is done. At the same time, by feeding on insect pests of the plant, the borer may be of a certain amount of benefit. What benefit may accrue cannot be ascertained until its feeding habits have been properly made out. The borings are not of such a severe nature as in the case of the red borer, but they are of sufficient severity to give a serious set-back to young tea, and to any cut-back tea on which a good growth of wood has to be left, so that the beneficial effect of the presence of the insect will need to be considerable if it is to be regarded as otherwise than a pest. Notice of the occurrence of this pest in the districts, and any information regarding its behaviour, together with specimens, will be welcomed.

HUMIDIFICATION IN TEA FACTORIES

BY

C. R. HARLER

The Fermenting Room Atmosphere. Experience has shown that, in the manufacture of black tea, the atmosphere of the room in which rolled leaf is fermented should be cool, humid and fresh. It is customary to construct fermenting rooms so that these conditions shall be realised. The general practice in North East India is to ferment the leaf in a brick walled room built below a withering house, a location which ensures a certain degree of coolness. It is usual to perforate the wall and to hang over the perforations hessian curtains which are kept wet. These arrangements aim at supplying fresh, humid air to the room.

The main chemical reaction taking place during the so-called "fermentation" of rolled tea leaf is the oxidation of tea tannin, whereby the green colour turns to a copper-red. A minor reaction is the development of the tea aroma which, from the point of view of quality, however, is a most important one. The ideal fermentation of tea is such that the oxidation has proceeded far enough and the aroma is developed to its fullest at about the same time. During fermentation the leaf absorbs oxygen from the air, which is used to oxidise the tannin, and liberates carbonic acid gas.

The chief influence of temperature on the fermentation process is the alteration of the speed of the reaction. Thus the raising of the temperature hastens the fermentation and reduces the time necessary for its completion. Yet there is a very definite limit beyond which an increase of temperature is undesirable, partly because at temperatures much above 80° F. micro-organisms producing "taints" appear to be very active, and partly because the oxidation seems to go ahead of the development of the aroma at high temperatures.

At temperatures much below about 75° F. the oxidation is slowed up so much that the synchronisation of this process

and the formation of the aroma is again lost. Experience has shown that the best results are obtained when the temperature of the fermenting room is between 75° and 80° F. In some places, *e.g.*, Darjeeling and parts of Java, the fermentation is often carried on in places warmed artificially so that temperatures approaching 80° F. are realised. In North East India, where the temperature during the greater part of the manufacturing season rises to about 90° F. each day, a temperature of 80° F. in the fermenting room is aimed at, and is considered cool.

Although the room temperature is kept at 80° F., there is a rise of temperature in the fermenting leaf, which may amount to as much as 5° or 6° F., if the leaf is spread thickly. This rise is steady to a maximum, at which it keeps till oxidation is finished, after which there is a fall in the leaf temperature to that of the room. The thinner the spreading of the leaf the less is this rise in temperature.

A high degree of humidity is necessary in the fermenting room, more especially when the temperature is high. Yet the deposition of moisture on the fermenting leaf should be avoided and on this account a humidity just under saturation point (about 95%) is desirable. If the atmosphere is kept humid during fermentation the colour of the infused leaf is brightened. The exact relationship between humidity and colours is not known, but it is probable that the film of moisture on the leaf plays an important part. In a dry atmosphere this film evaporates and dull, blackish colours are obtained.

Often in dry weather it is necessary to spread fermenting leaf thickly in order to minimise surface blackening. Thick spreading, by reducing the air supply to the leaf, slows up the rate of oxidation and entails a longer fermentation in spite of the higher temperature induced by this process. A high humidity allows of thin spreading which makes for even colours.

Nothing more definite about the air supply in a fermenting room can be stated than that it must be fresh. A dry draught blowing on the leaf is known to be bad, for the leaf is thereby

dried and dull colours result. If the air is cool and humid, however, a draught is an aid to oxidation.

The control of the atmosphere of the fermenting room by means of mechanical humidifiers was practised in a Dooars tea factory over twenty years ago, but it is only during the past five years that the extensive use of humidifier systems has been in vogue in North East India. At present about 60 factories have installations. In Java the use of humidifiers is common.

The Vortex humidifier, a type commonly used in cotton mills, is generally employed at present in North East India tea factories. By this system, water under pressure is forced through a small nozzle and enters the air as a fine spray, with a cooling and humidifying effect. The cooled, moistened air as it leaves the humidifier settles over an area of 400 to 500 square feet. Assuming that a fermenting room capable of dealing with about 10,000 maunds tea in the season under conditions in North East India should have a floor space of about 6,000 sq. ft., it will be seen that, for such a crop, about 12 Vortex humidifier units are necessary.

Vortex humidifiers may be placed at a height of about 7 feet above the floor and some of them, at any rate, should be fitted with air ducts which lead either directly through the roof or out laterally through the wall. In cases where the fermenting room is so low that head room of 7 feet is not possible, the cylinder of the humidifying unit may pass through the ceiling so that only the lower part of the unit, from which the spray is discharged, is in the room. In such cases, by a simple baffle arrangement, the spray as it leaves the humidifier is deflected towards the floor. Under ordinary conditions the spray moves upwards for a few inches after it leaves the humidifier.

Each humidifier can draw in up to 1,000 feet of air per minute, and hence is a great aid to keeping the air of the fermenting room fresh. Each humidifier discharges about 26 lbs. (about $2\frac{1}{2}$ gallons) water per hour into the atmosphere.

When the water is forced through the humidifier nozzle it is split into small drops, a process termed "atomisation." The minute drops evaporate rapidly by virtue of their large specific surface and moisture enters the atmosphere as vapour, thereby raising the humidity. The rapid evaporation of the water appreciably cools the atmosphere.

It has been observed in fermenting rooms that, with the usual free ventilation and under normal atmospheric conditions, it is possible, on humidifying the air up to about 95% relative humidity, to reduce the temperature to 1° or 2° F. above that of the wet bulb reading of the outside air. Thus, if the dry and wet bulb readings of the outside air are 88° and 80° F., this air, humidified up to 95%, is discharged from the humidifier at a temperature of about 81° or 82° F. It follows then, that, within limits, the drier the atmosphere drawn into the humidifier, *i.e.*, the greater the difference between the wet and dry bulb readings, the greater is the possible reduction in the room temperature following on humidification.

It will also be understood that air drawn in from outside, where it usually shows a lower wet bulb reading than inside the room, is capable of a greater lowering of temperature, following on humidification, than the air inside the room. On this account, in addition to the advantage of a fresh air supply, air ducts should be fitted to some of the humidifiers.

The reduction in the air temperature is partly controlled by the temperature of the water entering the humidifier. The lower this is, the greater will be the reduction in the temperature of the humidified air.

As mentioned above, each humidifier unit draws in about 1,000 cub. ft. of air per minute and discharges about 26 lbs. water into the air per hour. This amounts to a possible addition of about 2.9 grains water vapour to each cubic foot of air passing through the humidifier. If the loss of humidified air from the fermenting room were no greater than the air drawn through the humidifiers there would generally be more than sufficient water vapour entering the atmosphere to keep it at 95% relative humidity.

However, because of the open nature of most fermenting rooms, the air loss is considerable, and when the difference between the wet and dry bulb readings of the outside air is more than about 12° F., there is difficulty in keeping the humidity up to 95% in the average fermenting room supplied with the number of humidifier units mentioned above. Such periods of dryness are, however, rare in North East India.

When the air is so dry that the humidifiers are incapable of raising the humidity to the required figure, the fresh air supply should be reduced by partially closing the air ducts.

Without the installation of air ducts there is naturally much less control over the air passing through the humidifiers, although the intake of fresh air is considerable in a well ventilated room. Readings taken in a factory in Upper Assam (1) illustrate what temperature and humidity changes may reasonably be expected with humidifiers not fitted with air ducts. The first table shows typical readings taken during the rains. The figures in the columns denote the readings of the dry and wet bulb thermometers, the difference between these two readings, and the relative humidity (R. H.).

Date—September 1st, 1928.

Time	Outside in Shade				Fermenting Room				Remarks
	Dry.	Wet.	Diff.	R.H.	Dry.	Wet.	Diff.	R.H.	
	°F	°F	°F	%	°F	°F	°F	%	
5 a.m.	76	76		100	79	79		100	
6	77	77		100	79	79		100	
7	79	79		100	80	80		100	
8	82	80	2	90	81	81		100	
9	84	80	4	80	81	80	1	95	
10	85	81	4	80	83	81	2	90	Humidifier started.
11	86	82	4	80	83	82	1	95	
Noon	88	83	5	77	83	82	1	95	Bright sunshine.
1 p.m.	89	83	6	73	83	82	1	95	" "
2	90	83	7	69	83	82	1	95	" "
3	90	82	8	65	83	82	1	95	" "
4	91	83	8	65	84	82	2	90	" "
5	89	82	7	69	84	83	1	95	
6	86	82	4	80	84	83	1	95	
7	85	82	3	85	83	82	1	95	Humidifier stopped.

(1) We are indebted to Mr. Wm. Reid, of the Upper Assam Tea Co., for these and other readings made in detail over two seasons.

Up to about 10 a.m. the fermenting room atmosphere was generally cooler than that outside and just as humid. After 10 a.m. the air outside began to warm up rapidly and to become dry, which process was also observed, but at a slower rate, in the fermenting room. At 10 o'clock the humidifiers were started and from that time on were able to keep the temperature from rising appreciably.

The second table shows typical readings taken in May, during a hot dry 'spell.

Date—9th May, 1928.

Time	Outside in Shade				Fermenting Room				REMARKS
	Dry.	Wet.	Diff.	R. H.	Dry.	Wet.	Diff.	R. H.	
	°F	°F	°F	%	°F	°F	°F	%	
4 a.m.	76	74	2	89	76	76		100	Still, dry morning.
5	76	74	2	89	76	75	1	94	Bright and clear.
6	77	74	3	84	76	75	1	94	
7	77	74	3	84	76	75	1	94	
8	81	75	6	72	77	75	2	89	Humidifier started.
9	82	75	7	68	78	76	2	89	
10	85	77	8	64	80	78	2	90	
11	87	79	8	65	80	79	1	95	
Noon	88	79	9	61	81	80	1	95	
1 p.m.	89	79	10	58	81	80	1	95	
2	91	80	10	56	82	80	2	90	
3	92	80	12	53	83	80	3	85	
4	91	79	12	53	82	80	2	95	
5	90	79	11	56	82	80	2	95	Humidifier stopped.

It is often suggested that the need for humidifiers is limited to a few weeks before and after the Monsoon. This is incorrect, for during sunny periods of the rains the difference between the wet and dry bulbs is often as much as 10° F. The wet bulb temperature seldom rises much above 83° F. although the dry bulb very often touches 90° F. and above.

Observations made in Upper Assam over the greater part of two seasons have denoted that humidifiers were needed as follows :—

Months	1928 Season		1927 Season	
	No. of Days Humidifiers used	Total Hours	No. of Days Humidifiers used	Total Hours
	Days	Hours	Days	Hours
March	5	52	...	...
April	15	126	...	...
May	20	125	19	175
June	16	81	24	76
July	19	104	27	46
August	18	104	26	71
September	17	52	26	24
October	17	72	26	111
November	24	131	26	174
December	1	4	2	14

In many factories humidifiers are installed in the rolling as well as in the fermenting room. It is very necessary that the atmosphere of the rolling room should be cool, as near 80° F. as possible, but a high degree of humidity is not essential, except in the vicinity of the green leaf sifters. As a means of lowering the temperature in the rolling room humidifiers are recommended if other methods fail.

With the increased control of atmospheric conditions which mechanical humidification gives, the need for a separate rolling and fermenting room no longer exists and it is suggested that both operations be carried out in the same room, whereby labour is saved and supervision improved.

In such a combined room humidification would necessarily be carried on both in the rolling and fermenting divisions. The room should be light to facilitate operations, but must be reasonably enclosed if the atmospheric conditions are to be controlled. The fermenting space should be on the darker cooler side of the room. No proof has been obtained that light is detrimental to

tea fermentation, but direct sunlight has been shown to be inimical to good colours. This may be explained by the drying which takes place and also by the high temperature developed in direct sunlight.

Humidity is measured by means of a hygrometer which consists of two identical thermometers, one marked Dry and the other Wet. The bulb of the wet thermometer is covered with thin muslin, and round the neck of the bulb and over the muslin is twisted loosely, or tied in a loose knot, a conducting thread of lamp wick or common darning cotton. This passes into an adjacent vessel of water, placed at such a distance as to allow a length of conducting thread of about three inches. Rain or distilled water should be used in the reservoir.

Although wet and dry bulb thermometers are installed in most tea factories they are frequently wrongly used. The hygrometer should not be kept in a draught, but, at the same time, it should not be boxed in. Before reading it should be taken down from the wall, swung gently once or twice and read after an interval of a few seconds.

The humidity is calculated from tables. The *relative* humidity is a percentage, representing the actual moisture in the air as a proportion of that necessary to saturate the air at the given (dry bulb) temperature. Thus wet and dry readings of 75° and 80° F. denote a relative humidity of 75% showing that the air at that particular temperature, *viz.*, 80° F., is three-quarters saturated. A relative humidity of 100% denotes complete saturation and any cooling of the air when it is in this state is followed by deposition of moisture as dew or rain. The *absolute* humidity or vapour tension is the weight of water vapour in the air and is expressed in inches of mercury pressure. Thus a vapour tension of 0.75 inches denotes that, of the total atmospheric pressure, *i.e.*, barometric pressure of about 29 inches, 0.75 inches are due to the weight of the water vapour present.

It will be understood that it is possible and common for the absolute humidity or actual water content of the air to remain constant but for the relative humidity or drying capacity of the air to change. Thus when air is drawn into a Drying machine, the absolute humidity is not changed but the temperature is raised and the relative humidity thus lowered. The relative humidity is a measure of the drying capacity of the air and is the factor which is of importance in withering, fermenting and drying tea leaf.

Humidity tables are usually given in such detail that they are a source of confusion to the uninitiated. The hygrometrical tables published by Messrs. Mather and Platt, the manufacturers of the Vortex Humidifiers, are simple and sufficient. The table given below will be found to cover the temperatures ordinarily recorded in the tea areas of North East India.

Table Showing Wet and Dry Bulb Readings and Relative Humidity.

Wet	Dry	Relative Humidity	Wet	Dry	Relative Humidity	Wet	Dry	Relative Humidity
°F.	°F.	%	°F.	°F.	%	°F.	°F.	%
74	74	100	75	75	100	76	76	100
	75	95		76	95		77	95
	76	90		77	91		78	91
	77	86		78	86		79	86
	78	82		79	82		80	82
	79	78		80	78		81	78
	80	74		81	74		82	75
	81	70		82	71		83	71
	82	67		83	67		84	68
	83	64		84	64		85	64
	84	60		85	61		86	61
77	77	100	78	78	100	79	79	100
	78	95		79	95		80	95
	79	91		80	91		81	91
	80	87		81	87		82	87
	81	83		82	83		83	83
	82	79		83	79		84	79
	83	75		84	75		85	76
	84	71		85	72		86	72
	85	68		86	68		87	69
	86	65		87	65		88	66
	87	62		88	62		89	63

Wet	Dry	Relative Humidity	Wet	Dry	Relative Humidity	Wet	Dry	Relative Humidity
°F.	°F.	%	°F.	°F.	%	°F.	°F.	%
80	80	100	81	81	100	82	82	100
	81	95		82	96		83	96
	82	91		83	91		84	91
	83	87		84	87		85	87
	84	83		85	83		86	84
	85	79		86	80		87	80
	86	76		87	76		88	76
	87	72		88	73		89	73
	88	69		89	69		90	70
	89	66		90	66		91	67
	90	63		91	63		92	64
83	83	100	84	84	100	85	85	100
	84	96		85	96		86	96
	85	91		86	92		87	92
	86	88		87	88		88	88
	87	84		88	84		89	84
	88	80		89	80		90	80
	89	77		90	77		91	77
	90	73		91	74		92	74
	91	70		92	70		93	71
	92	67		93	67		94	68
	93	64		94	64		95	65

THE TOCKLAI CLEARANCE

BY

C. J. HARRISON

The block of tea known as the Tocklai Clearance comprises the major portion of the small planted area at Tocklai, and is put out in six blocks of equal area, with different types of bushes. It originally consisted of eight half acre blocks, but two of these, containing the Manipuri and Burma types, have since been removed. These six types of tea now under view are, in order from the south to the north end--Kalline, China, Kharikatia, Singlo, Betjan and Panighat.

A full account of the planting and early treatment of this clearance is given in a previous issue of the *Quarterly Journal*, but a brief resumé of some of the salient points in the history of these plots will be of interest.

The land on which the tea was put out is old grazing land, chemically very poor but mechanically fairly good, though, as is often the case with fine sandy silts, it sets hard after rain.

Before planting, 10 maunds per acre slaked lime was applied together with cattle manure, while a very good crop of Boga medeloa was grown and hoed in.

The following cold weather (1914-1915), the first six half acre blocks were planted with one year old plants of Manipuri, Burma, Kalline, China, Kharikatia, Singlo varieties planted 5 ft. x 5 ft. square, and all excepting the Singlo variety were from good nurseries. Careful weeding out of plants apparently not "true to type" was carried out in the nursery before planting. In 1915, Boga medeloa was grown, lopped and hoed in at intervals, while draining was completed also during this year.

Fifteen maunds lime, together with organic manure and phosphates was given in 1916, and at the end of the rains the bushes on all plots were cut down to 2 inches except in the case of plants

under 1 inch in stem thickness which were cut next spring. Plucking commenced the following year at 27".

In July 1915, seven months old plants were put in on a further two half acre blocks, one of Betjan and the other Panighat. These made rapid growth and by 1920 had reached the level of the older plots in annual yield. A brief description of the varieties of tea now in this clearance is perhaps of interest.

Kalline (North-west Cachar). Dark, healthy leaf, many bushes very large. There are some hybrid bushes in the plot, and seeding is apparent to a greater extent here than on Kharikatia, Singlo, Betjan or Panighat.

China (South Cachar). Appears much better than average China bushes and though the dull green colour of the leaf and the reddish brown petiole is characteristic of the China variety, the bushes on the whole appear more like good hybrids. The bushes flower and seed very readily, a sign of China *jat*.

Kharikatia (Middle Assam). This is a light leaved Assam variety from a local seed garden put out with Singlo seed. It is possibly stronger than actual Singlo seed grown in this district, having to some extent acclimatised itself. In spite of rather a poor start it has of late years been equal to any variety in Tocklai, and better than many. The leaves are very long, narrow and pointed.

Singlo (Middle Assam). This had much the poorest start of any of the varieties and has only recently shown satisfactory yields. With shade it would undoubtedly benefit to a greater extent than the other varieties as it bears a very light leaf and suffers in droughty periods.

Betjan (Upper Assam). A large light leaved Assam variety though darker than Singlo or Kharikatia. It has grown splendidly from the start and is the best plot on the clearance.

Panighat (North Cachar). This is a dark narrow leaved variety which has grown well and does not appear to suffer much from leaf diseases.

Annual yields of annually pruned & biennially pruned tea



Up to 1920 the half acre plots were plucked and pruned as a whole, and included the Manipuri and Burma plots, since removed. The order of yield to the end of 1919 was—

		Total Yield		Average Yield	
		Mds.		Mds.	
*Burma	...	...	16.60	...	5.53
*Kalline	...	...	16.25	...	5.42
*Manipuri	...	...	16.21	...	5.40
*Kharikatia	...	...	14.23	...	4.74
*China	...	...	13.98	...	4.66
*Singlo	...	...	10.58	...	3.53
**Betjan	...	...	9.99	...	5.00
**Panighat	...	...	8.50	...	4.25

*3 years plucking.

**2 years plucking.

One maund equals 80 lbs.

Trial of Biennial against Annual Pruning

The plots were divided in halves in 1920, one half being plucked 17 inches above the 10-inch pruning cut, and the other half being skiffed. In the following year the previously pruned half was pruned leaving 2 inches new wood while the previously skiffed half was pruned to 10 inches—2 inches above the previous 8-inch pruning in 1918-1919.

Up till and including 1924, half of each plot had been pruned successively leaving 2 inches of new wood, while the other half was pruned only every alternate year, and skiffed in the intervening year. From 1924 the programme continued the same except that the biennially skiffed plots were no longer skiffed, but left entirely unpruned in alternate years.

From a study of Table I and the curve it can be seen that on two occasions only has the average yield per acre from the biennially pruned plots exceeded that of the annually pruned plots, *i.e.*, in 1920 and in 1924. The excess in these years was considerable but was counterbalanced by the deficit in other years and taking the total yields year by year up to the end of 1928, nine years from the commencement of the experiment, the annually pruned plots have exceeded in yield the biennially pruned plots.

One can say that the only gain resulting in this case from leaving the tea *unpruned every alternate year* is a saving in cost of pruning, though this is discounted somewhat by the greatly increased care necessary in pruning the tea in the following year, so as to remove all dead snags which have been on the bush for two years. Furthermore on bushes at this stage of growth, cuts on two year old wood heal unsatisfactorily or not at all, and provide points of attack for wood fungi. With the better system of leaving bushes unpruned every third year, and with careful pruning in the other two years, troubles arising from dead snags are largely eliminated.

Trials of Different Varieties of Tea

In assessing the results with a view to deciding the most successful type of tea on the clearance there are one or two points needing consideration. Firstly, two varieties, Betjan and Panighat, were planted one year later than the other four varieties. Secondly, there is a distinct difference in soil conditions as we go from plot to plot.

With regard to the first point, if yields are taken from the time the tea was cut back in the cold weather 1918-1919, after which yields were of the same order for both earlier and later planted, a fair comparison can be made, *vide* Table II. In any case, however, the order of yields of the different *jats* is unaffected whether or not the above correction is applied.

Average annual yields to date in maunds per acre.

		1917-1928	1919-1928
		mds.	mds.
Kalline	.. sl	9.51	10.22
China	.. "	7.29	7.77
Kharikatia	.. sl	9.83	10.74
Singlo	.. "	8.80	9.77
Betjan	.. "	10.72	11.23
Panighat	.. sl	9.73	10.20

The Betjan plot stands out as being easily the best plot, with the Kharikatia about half a maund per acre per annum poorer. Kalline and Panighat are practically equal, and $1\frac{1}{4}$ mds. per acre per annum poorer than the Betjan tea. The Singlo tea, which started very poorly, has never made up for

this bad start, and appears to need shade to a greater extent than do the other types. It suffers from adverse climatic conditions to an extent which is more marked than with the other types and would probably have benefited more than the others by lighter plucking under unfavourable conditions.

The China *jat*, which comes last in order of yield, has nevertheless done surprisingly well to give an average of $7\frac{3}{4}$ mds. over the whole period. With closer plucking a much bigger yield, with little adverse effect on the health of the bush, could have been obtained, since with China and low hybrid, leaving 6 inches or more of new wood results in greater tendency to flowering than would be the case if closer plucking were adopted.

In comparing these blocks of tea another disturbing factor occurs, due to the lie of the land relatively from plot to plot. This affects mainly the end nearest the laboratories, occupied by the Kalline tea. Here, especially near the main road, the land is rather low and is the first to suffer from excess of water in the soil. The land slopes very slightly up from this end roadside plot, to the further end remote from the road, occupied by Panighat tea.

Furthermore, the acidity of all the plots is not identical. The roadside plots of Kalline and China have a Hopkins acidity of about 30, and the demaining halves of these plots, an acidity of about 80. The remaining plots all have an acidity round about 200. It would be expected therefore that the Kalline and China plot would be somewhat adversely affected by the low acidity as compared with their neighbours more fortunately situated in this respect.

The chief interest in these plots, apart from the trial of pruning, lies in the demonstration that, given adequate manuring and treatment, high yielding tea whatever its *jat*, can be grown on comparatively poor soil without shade.

REFERENCES

- Quarterly Journal 1916, Pt. IV, page 121.
 " " 1921, Pt. I, page 32.
 " " 1926, Pt. I, page 24.

TABLE I
Tocklai Clearance
 Yield of tea in maunds per acre.

Year	1920	1921	1922	1923	1924	1925	1926	1927	1928	Total to Date	Average Annual Yield	Difference between A and B.
Pruning	A. 10" B. Skiffed	A. 14" B. 10"	A. 16" B. Skiffed	A. 18" B. 14"	A. 20" B. Skiffed	A. 22" B. 16"	A. 24" B. Un- pruned.	A. 26" B. 18"	A. 28" B. Un- pruned.			
Kalline { A. { B.	5.13 11.34	9.74 8.17	12.50 10.95	12.72 9.90	12.08 14.86	11.43 7.91	10.55 7.96	14.25 10.87	13.45 11.89	101.85 93.85	11.32 10.43	{ - 0.89 }
China { A. { B.	4.02 10.88	7.13 8.84	12.12 8.70	8.58 8.38	6.70 11.78	5.71 6.88	6.88 5.96	9.66 9.03	9.41 8.96	70.21 79.41	7.70 8.82	{ + 1.12 }
Kharikatia { A. { B.	4.39 11.52	9.39 8.11	14.31 13.39	14.70 10.70	11.93 14.96	12.49 8.76	11.90 8.75	14.19 12.09	14.49 11.42	107.79 99.70	11.97 11.08	{ - 0.89 }
Singlo { A. { B.	4.32 9.91	8.21 7.27	12.21 10.90	11.77 9.65	10.78 13.60	10.10 9.15	9.76 10.11	12.46 12.33	13.52 13.92	91.13 96.84	10.12 10.76	{ + 0.64 }
Betjan { A. { B.	5.71 14.29	10.58 9.16	13.00 12.25	16.00 11.76	14.46 14.50	13.72 9.60	11.01 7.45	13.65 11.66	15.59 11.59	113.72 102.36	12.64 11.36	{ - 1.28 }
Panighat { A. { B.	4.57 11.77	8.82 7.65	12.42 10.77	11.99 10.19	12.32 11.50	13.46 10.60	9.32 9.09	11.53 11.54	13.65 12.78	98.08 98.98	10.90 10.99	{ + .09 }
Average of { A. { B. all plots {	4.69 11.62	8.98 8.20	12.76 11.16	12.63 10.43	11.38 13.90	11.15 8.80	9.90 8.22	12.62 11.25	13.35 11.76	97.47 95.91	10.78 10.58	{ - .20 }

TABLE II

Tocklai Clearance

Yield of tea in maunds per acre.

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	Total	Average Annual omitting 1917-18	Order of Yield ^a	
Kalline ...	2.53	9.34	4.38	8.23	8.95	11.72	11.31	13.47	9.67	9.26	12.56	12.67	114.09	9.51	10.22	3
China ...	2.05	7.67	4.26	7.45	7.98	8.91	8.48	9.24	6.30	6.42	9.40	9.29	87.45	7.29	7.77	6
Kharikatia ...	2.62	7.95	3.66	7.95	8.75	13.85	12.70	13.44	10.62	10.32	13.14	12.96	117.96	9.83	10.74	2
Singlo ...	1.76	6.05	2.77	7.11	7.74	11.55	10.71	12.19	9.62	9.93	12.40	13.72	105.55	8.80	9.77	5
Bejian ...	...	5.64	4.35	10.00	9.87	12.62	13.88	14.48	11.66	9.23	12.65	13.59	117.97	10.72	11.23	1
Panighat ...	...	4.95	3.55	8.17	8.23	11.59	11.09	13.41	12.03	9.20	11.54	13.22	106.98	9.73	10.20	4
Average of all plots ...	2.24	6.93	3.83	8.15	8.59	11.71	11.35	12.70	9.98	9.06	11.95	12.57	109.06	9.31	9.99	

VEGETABLE PARASITES OF THE TEA PLANT

(Continued)

BY

A. C. TUNSTALL

BLIGHTS ON THE ROOT

Thyridaria tarda, Banc. = *Botryodiplodia Theobromae*, Pat.

Internal Root Rot, *Diplodia* Disease, Tired Area Disease.

Refs. :—Watt and Mann, "The Pests and Blights of the Tea Plant," 2nd ed., p. 414.

Butler, "Fungi and Disease in Plants," p. 445.

Petch, "Diseases of the Tea Bush," p. 149.

Indian Tea Association, Pamphlet I, 1918, "Tea Roots," Part II.

Indian Tea Association, "Quarterly Journal," Part III, 1915, p. 56.

Arch. Voor Theecult Nederl-Indie ii., 1—2, pp. 59-73, 1928. Reviewed in the Review of Applied Mycology, Vol. VIII, Part 2, p. 70.

Butler—Report on some Diseases of Tea and Tobacco in Nyasaland. Issued by the Dept. of Agri., Nyasaland, July, 1928.

Gadd—Tea Research Inst. of Ceylon "Tea Quarterly," Vol. I, Part 4, 1928.

Found in all the districts.

History :—The disease was reported on tea in Assam in 1901. It was believed at the time that the infection occurred through the seed. But subsequently it has been found that this is not the only source of infection.

Owing to the variability of the fruiting stage of the fungus it has been given a number of different names. The fungus is

most probably identical with that which is called *Botryodiplodia Theobromae*, Pat., in Ceylon and Java. The descriptions of the *Diplodia* form are in close agreement. In North East India however we use the name *Thyridaria tarda*, Banc., for the following reason. Dr. Butler drew the writer's attention to Bancroft's work in the F. M. S. and suggested that in all probability the *Diplodia* on tea was the same fungus. Bancroft was of opinion that a fungus which he named *Thyridaria tarda* was the perfect form of the *Diplodia* fungus. With Bancroft's description before him the writer searched for the *Thyridaria* form and found it on some tea branches received from Doom Dooma. He later found it on roots from the same district. It was later received from two gardens in the Surma Valley. In each of these cases the *Diplodia* pycnidia were also present. Ascospores from two of these specimens were grown in pure culture and produced pycnidia typical of *Diplodia*. So far it has not been found possible to induce cultures from the *Diplodia* spores to form mature perithecia. As it is customary to give fungus of this nature, having more than one form, the name by which the perithecial stage is known, *Diplodia* Sp., and *Botryodiplodia Theobromae* were superseded in favour of *Thyridaria tarda*, Banc.

Description :—The symptoms of the disease are not the same in all cases. A plant may be affected for many months and yet continue to look healthy. Suddenly, without any warning, the bush dies with all its leaves attached as though it had been struck by lightning. In other cases the leaves may take on a yellow appearance and the veins of the leaves darken a little in colour, defoliation then occurs gradually and the bush dies branch by branch. The yellow mottling of leaves as described by Petch is common in North East India but it is not found to be characteristic of the disease in question. It is associated with the debility of the plants concerned, not with infection by any particular fungus.

The fungus attacks the stems as well as the roots. When the fungus is confined to the stems it causes die back. But when

it attacks the roots the whole bush frequently dies. The fungus is not, strictly speaking, a root disease as it generally infects the plants through wounds in the stems, whence it extends to the root. The fungus is occasionally found in the green parts of the plant. On a number of occasions fructifications have developed on young green leaves. In some cases infection takes place below ground through damaged roots. The fungus may live quite a considerable time in the wood without causing any apparent damage to the host plant. After a time it may invade the tissues actively engaged in the transmission of the sap. The plant then dies very suddenly. For some reason or other pruning frequently accelerates the last stage and plants die about six weeks after pruning. Gadd supposes that such bushes die for want of sufficient reserve starch in the roots to furnish supplies for the development of new shoots and leaves after pruning; and that on the death of the plant the tissues become invaded by *Botryodiplodia* and other saprophytic fungi. The tests carried out by him on roots which have died of the so-called *Diplodia* disease after pruning have shown that in every case he examined the roots of the diseased bush were destitute of starch. But the writer does not find that such correlation exists in North East India. Bushes have been frequently observed with the roots and trunk so badly attacked by the *Diplodia* fungus that the wood was darkened throughout yet containing abundant starch. Such bushes produce new shoots after pruning but after the latter had attained some length they died back and the fungus is found to have invaded the tissues at their bases. More shoots continue to be produced only to die like their predecessors until ultimately the whole bush dies.

In the case of young plants attacked by this disease it is sometimes noticed that there is a deficiency of starch in the outer layers of the wood in the roots and branches.

At the time of death the roots of tea infected with this fungus appear to be quite normal externally. If the wood be laid bare it will often be found to be coloured in pale grey

streaks as though it had been dipped in ink. The spores are produced in the bark of the root some time after death. The root then presents a sooty appearance. The mycelium is wholly internal. It occupies the cortex, wood and the pith. It chiefly accumulates in the medullary rays. The colour is hyaline at first changing later to a very dark brown.

The common kind of fructification is black spherical bodies (pycnidia) either half embedded in the bark or produced in clusters in a stroma on the exterior of the bark. The pycnidia are globose or sub-globose, ostiolate and dark brown to black in colour. In some cases the pycnidia are covered with hairs. The pycnospores are oval or ovoid, densely granular, often very thick walled. They are at first hyaline and continuous but afterwards they take on a yellowish brown tinge and ultimately become dark brown in colour and uniseptate. The dark brown uniseptate spores have longitudinal striations. They measure 29.5 by 14.75 μ . The spores are borne on short conidiophores and are liberated in threads through the ostiole of the pycnidium. These spore threads are at first white but afterwards become black. Paraphyses are present.

Sometimes the black spots on the bark which mark the position of the pycnidia are fringed with a white chalky powder. This is commonly the case when the bushes are growing in a heavy stiff soil. The white powdery substance is the mycelium and chains of spores of another fungus possibly parasitic on the *Thyridaria tarda*.

The other form of fructification, the perfect stage of the fungus, is found on the stem and exposed portion of the root. It is very uncommon. It has so far only been found on four occasions. The perithecia are immersed with the mouth projecting. The asci are cylindric-clavate either sessile or with a very short stalk and contains 8 spores. The ascospores are arranged in irregular rows, they are oblong, triseptate slightly constricted at the septa and of dark brown colour. The asci measure from

115 to 150 by 18 to 26.5 μ , the ascospores measure from 26 to 28.5 by 6.4 to 9 μ , and the paraphyses are 130 to 450 μ in length. This form has not been produced in culture but immature pycnidia typical of the *Diplodia* fungus have been obtained from cultures of the ascospores obtained from two specimens.

The fungus is probably most commonly distributed by the air. Infection appears to take place principally through wounds which expose woody tissue. Watt & Mann suggested that infected seed may be an important factor in distribution. In 196,224 seeds examined during the past five years only 133 seeds were found to be infected by this fungus. Seed, though a possible source of infection, is not therefore likely to be a serious one.

Depredations :—The disease is most frequently found on tea, especially young tea, growing on coarse sandy soils. It is however by no means confined to these soils. It has been found on tea plants struggling to keep alive on some of the stiffest soils in North East India. These soils are often neutral while the sandy ones are generally acid. Acidity of the soil therefore does not appear to have any direct influence on the presence of the fungus. It is however obvious that really vigorous plants are not seriously affected. Observations on tea at Borbhetta which had been heavily manured with phosphates showed that most of the bushes so manured were badly attacked. The addition of heavy doses of potash caused these bushes to recover and it was thought that deficiency in potash in the soil was a predisposing factor. Later observations however show that deficiency in phosphates is also associated with increased susceptibility to the disease. It is probable that anything which causes the tea bush to lose vigour is likely to increase susceptibility. Prolonged drought and the opposite extreme, prolonged water-logging, seem to be equally important as predisposing factors.

The most serious losses, caused by the fungus, are on young tea, *i.e.*, plants up to three years of age. It frequently happens that, at the beginning of the season when the early rains have

fallen, here and there in a new clearance an apparently healthy plant dies suddenly without any apparent reason. Others at the same time begin to look sickly. If nothing be done the sickly ones die one after another. Examination of these plants shows that they are attacked by the *Diplodia* fungus. The mycelium of this fungus may be found in all parts of the sickly plants before they die.

The same sort of thing happens on all classes of soil but is most frequent on coarse sandy soils subject to drought. Mature and old tea plants on such soils also die in a similar manner in the rainy season succeeding a long period of dry weather. As a rule mature tea bushes even in these soils are not seriously attacked by this fungus unless they have already been damaged by some other agency. Sometimes these bushes die back gradually. In such cases should the bush concerned be cut back it may produce new shoots, but a few weeks after the new shoots appear the whole bush dies suddenly.

The fungus also frequently attacks collar-pruned plants. New shoots form, grow a few inches, and die down. Sometimes a few survive to form thin weedy branches but sooner or later the whole bush dies. Other agencies cause the death of collar-pruned bushes in much the same way but this fungus is one of the commonest causes of such deaths.

Remedies :—The fungus is an exceedingly common saprophyte in North East India and if it were able to attack all tea bushes indiscriminately few would survive. Spores of the fungus may be found in the air in the neighbourhood of Tocklai at any time of the year. It is obvious therefore that the eradication of the fungus is out of the question. Experience has shown that the most satisfactory method of dealing with this disease is by the treatment of the host plant, not the parasite.

There is no doubt whatever that a young bush attacked by *Thyridaria tarda* can be cured if treated in time. Wherever bushes begin to die out suddenly for no apparent reason the dead

plants should be removed and burned as they may become centres of infection for many diseases. All sickly looking bushes in the neighbourhood of the dead ones should be manured at once with a mixture containing readily available potash, phosphoric acid and nitrogen. If the soil be dry the manures may be applied in liquid form to the soil round the plants. The application should be repeated about two months later. The proportions of the mixture and the quantities are not given here as they should be determined respectively by the soil conditions and the size of the plants. A quantity of a mixture suitable for the soil concerned should be kept in stock on all gardens. Apart from the consideration of this disease in particular it should be part of the general routine to manure, specially, young plants which are less vigorous than their neighbours. In the case of old tea bushes it is often doubtful whether special manuring of the kind suggested for young plants pays. It often happens that the frames are rotten and in the absence of sufficient green shoots the manure cannot be utilised. When plenty of green shoots are present on an old bush the application of readily available manurial substances to the soil will prevent this new growth dying back as the result of *Thyridaria* infection. In the case of collar-pruned bushes on which the new shoots are dying back in the manner described above such manuring will often save the bushes by preventing further dying back. The disease is sometimes found on bushes growing in soils which are known to be really good tea soils. The susceptibility of the plants may in such cases be influenced by temporary adverse soil conditions, *e.g.*, a drought or prolonged rainy period. The additional manuring advocated above will greatly facilitate the recovery of the diseased bushes even though the soil analysis may lead one to suppose that it is unnecessary.

The application of spray fluids, *e.g.*, Lime sulphur solution, after pruning will, by protecting the wounds, help to reduce infection by *Diplodia* spores. It is however doubtful whether such protection is likely to be very efficient against this fungus. Spraying by reducing the amount of damage done by fungus

blights on the stems and green shoots renders the bushes more vigorous and in consequence less susceptible to the attacks of *Thyridaria tarda*. It is however obvious that the plucking of sickly bushes does as much or more damage than fungi which reduce the active leaf area. It is therefore suggested that such bushes be rested or at any rate only lightly plucked until they become as vigorous as their neighbours.

Petch in Ceylon recommends that prunings from bushes in areas infected by this disease should be burned. In North East India this would mean that all prunings should be burned. This costly proceeding is unnecessary in the case of ordinary light prunings, which readily decay away. Heavy woody prunings should never be buried as they are always liable to cause trouble.

To summarise—

1. The application of a manure mixture containing readily available potash, phosphoric acid and nitrogen to sickly bushes is a valuable aid to recovery from attacks of this disease.
 2. Spraying with Lime sulphur solution after pruning assists in preventing infection of wounds and helps bushes attacked by this disease to recover by reducing the damage due to other blights.
 3. Resting sickly plants until they become as vigorous as their neighbours is also recommended.
-

TEA IN NORTH-EAST INDIA

BY

P. H. CARPENTER

HISTORICAL

Tea is prepared from the young leaves of the tea plant, *Thea sinensis* (L.) Sims. Linnaeus first published in 1737 the name of the genus as both *Camellia* and *Thea*, knowing at that time only two species, *japonica* and *sasanqua* of the former genus and the tea plant as the sole representative of the latter. As more related species became known, botanists of the nineteenth century gradually became convinced that the difference between the genera was so small that the separation was no longer useful. The united genus is known as *Thea*, since this name was the first mentioned by Linnaeus.

Linnaeus, in his *Species Plantarum*, 1762, distinguished between two varieties of tea, *Thea viridis*, giving rise to the green tea of commerce, and *T. bohea*, giving the black tea. With this distinction, the original name, *Thea sinensis*, was dropped. It was later shown that, whether tea was black or green, depended on the manufacture and not on the plant and that both could be made from the same leaf.

Sir George Watt, who made the first detailed study of the botany of the tea plant, considered two main varieties to exist, viz., *viridis* (large-leaved) and *lasiocalyx* (small-leaved.) From these two, the other varieties were thought to be derived by hybridization. Later workers have contested this conclusion.

Dr. Cohen Stuart considers that there exist at least two morphological groups of tea plants, one of which is indigenous to India and one to China, while there is no evidence supporting the old idea of any direct genetic or genealogical affinity con-

necting them. Later, the same botanist distinguished four groups as follows :—

- (1) The China group, small-leaved ($1\frac{1}{2}$ to $2\frac{3}{4}$ inches long) found in East and South-East China and Japan.
- (2) The group, variety *macrophylla* v. *siebold*, leaves up to about $5\frac{1}{2}$ inches long; found in Hupeh, Sechuan, Yunnan.
- (3) The Shan group, leaves up to 7 inches long, light coloured. Bushes 16-32 feet high, found in Tonkin, Laos, Upper Siam, Upper Burma (Shan States) and perhaps also Assam.
- (4) The Manipur group, leaves 8-12 inches long, dark coloured. Bushes 60 feet high, found in Manipur, Cachar, Lushai.

First mention of tea in India is made in 1780 when a few shrubs imported from Canton were planted in Calcutta. In 1788, Sir Joseph Banks studied the problem and suggested Bihar and Cooch Behar as suitable areas for tea culture. At this time Assam was not included in the British Empire. Although the East India Company were thus acquainted with the fact that tea could be grown in India, no advance was made until 1833 when the monopoly of the China tea trade was lost. In the following year a committee went into the matter and an experimental station was started on the slopes of the Himalayas at Kumaon. The seeds were imported from China and the methods of that country were generally adopted.

Soon after these experiments had been started, information came through that the tea plant had been discovered growing luxuriantly in the jungles of Upper Assam, at that time a country off the beaten track. The honour of this discovery is usually attributed to R. Bruce who saw the plant growing wild on some hills near Rungpore (Sibsagar), then the capital of Assam, which he visited in 1823 to prosecute certain botanical researches,

amongst other matters. At the same time he had made an arrangement with one of the Singpho chiefs for a supply of tea plants. Another story attributes the discovery to an Assamese named Moniram Dewan.

At this time Assam was included in the Burmese dominions, and in 1824 the Burmese war broke out and C. A. Bruce, brother of R. Bruce, was ordered to Sadiya in charge of a division of gunboats. On the capture of Rungpore, C. A. Bruce interviewed the Singpho chief who supplied him with tea bushes and seeds which were mostly planted in his (Bruce's) garden at Sadiya. The leaf of these plants was sent to the Botanical Gardens in Calcutta, but whilst it was pronounced to belong to the *Camellia* family and was thought to be a veritable tea plant, it was considered improbable that the Assam species would yield the tea of commerce.

So the matter was dropped until 1833 when C. A. Bruce again took up the question with such vigour that a committee was appointed to journey to Assam and report on the tea growing wild there. The report of this committee stated that the tea plant as it flourished wild in Assam had degenerated and that the importation of China plants was advisable.

Accordingly an experimental plantation was started at Sadiya with seed imported from China. The first tea was planted on a river sand bank near the Brahmaputra and the result was a failure. The next area was put out at Jaipur, again with China seed, and later, at Chabwa in the Dibrugarh district, because near here the Assam bush flourished wild. The result was a success. At this time Chinese were imported to work the gardens.

Bruce followed up his earlier discovery and later found tea in many tracts, the largest being at Namsang in the Naga Hills. Other big tracts were at Tipam and Gabru.

About the time Chabwa was planted, other small gardens round Tinsukia were also put out. In 1839 Lakhimpur and Sib-

sagar became part of the British Empire, and, soon after, the Government made over most of its tea areas, with the exception of Chabwa which had been sold to a Chinaman, to the Assam Company. In 1852 this company, the first tea company in India, paid its initial dividend. From this time on, the number of tea companies increased rapidly.

Meanwhile in 1855 indigenous tea was found in the Chankhani Hills in Sylhet and tea was put out in Cachar and Sylhet. Later on tea was found wild all along the Khasia and Jaintia Hills, and for some time the presence of indigenous tea was taken as the sign that the area was suitable for tea growth. The first tea in Cachar was put out in mauza Barsanjan in 1856, on the hill tops which stretched from the Barail range to the Barak. The *teelas* (hillocks) were next planted out and in 1875 the first *bheels* (swamps) were drained and planted. In Sylhet the first garden opened was Malnicherra in 1857.

About the same time Darjeeling embarked on the tea venture. By the end of 1856 tea plants had been cultivated at Tukvar, at the Canning and Hope Town plantations, on the Kurseong flats and between Kurseong and Pankhabari. After the industry was established as a commercial enterprise in the Darjeeling District, attention was paid to the Terai where Champita was put out in 1862. The land east of the Teesta was soon after explored and Gajaldhoba was planted in 1874, followed later by Phulbari (Leesh River) and Bagrakote. The tea area spread eastwards till it ultimately reached the Sankos, the boundary of Assam. Good *jat* indigenous tea was planted in place of the China bush with which the Western Doors and the Teria were planted.

The introduction of tea into Chittagong dates from the year 1840 when some China plants from the Botanical Gardens, Calcutta, and some seeds from Assam were planted in the pioneer garden in Chittagong, near where the Club now stands. This district is not favoured with a suitable climate and has not developed to any great extent.

ORGANIZATION

During the later decades of the nineteenth century many new gardens were opened out in Assam and were more or less family concerns. The later development has been in the direction of limited liability companies, and the tea industry to-day in North East India is a highly organized one.

The length of the journey from England to India made tea agency houses a necessity in the earlier days, and to-day, with improved methods of communication and the shortened journey, the agency system is still in force, for it combines the benefits of a steady policy in garden management and co-operation among sellers in shipping and marketing their crops. Most agency houses also have their holdings in the concerns they manage.

The Indian Tea Association, Calcutta, was formed at a meeting of Calcutta tea agency firms in 1881, the object and duty of the association being to promote the common interests of all persons concerned in the cultivation of tea in India.

The Association started with a membership of companies and estate owners representing a planted area of some 103,000 acres, which had increased at the end of 1926 to 523,840 acres. This area represents approximately 88 per cent. of the area under tea in North East India. In addition each district has its branch of the Association which deals with problems of local interest.

The tea industry in North East India also has an Association for managing its labour affairs and for recruiting labour. As early as 1859 it was realized that the importation of foreign labour was essential and a 'Tea Planters' Association was formed for the purpose, among others, of organizing a system of coolie emigration from Lower Bengal to Assam. The sudden expansion of the industry created a class of contractors who supplied labour to the tea gardens which were so rapidly being established, and the planter came in most cases to have no more connection with recruitment than was involved in paying for the coolie. The results were so disastrous owing to competition between

contractors that in 1861 Government appointed a committee to enquire into the system under which the emigration of labour was conducted.

As a result of this and other enquiries, various emigration acts were passed and finally in 1915 recruitment by contractors was abolished, and at present the only legal form of recruiting is done by garden sirdars working under a licensed local agent. A garden sirdar may be described as an individual employed on an estate as a labourer. The ideal is that such sirdars should recruit in their home district, preferably in and around their own villages. The duty of the local agent is to look after the interests of the garden sirdar.

In 1892 a meeting was called by the Bengal Chamber of Commerce to discuss the formation of an Association to deal with the question of labour supply to gardens. The outcome was the formation of the Tea Districts Labour Supply Association which took over the smaller Associations already in existence with the exception of the Assam Labour Association. The first recognition of the formation of these Associations was the granting of certain concessions by Government in connection with their operations. For instance, the power of local agents to act without the necessity of producing recruits before a magistrate was given.

In 1915 the Assam Labour Board was created to supervise the work of the local agents on behalf of Government. The Board was given the power to make recommendations regarding the licensing of local agents. Meanwhile the Assam Labour Association became amalgamated with the Tea Districts Labour Supply Association and in 1917 its denomination was altered to the Tea Districts Labour Association.

The Association is managed by a committee composed of members representing London and Calcutta interests and of planters from various tea districts. It is estimated that the Association controls recruiting for 95 per cent. of the estates in Northern India.

The Indian Tea Cess Committee was constituted under an Act the object of which was to provide for the collection of a fund to be expended for the promotion of the interests of the Indian tea industry. From the year 1893, the Indian Tea Association had been collecting a voluntary assessment for expenditure on the development of foreign markets for Indian tea. There were, however, objections to raising money by this system, and the Association resolved, if possible, to make the levy a compulsory cess. The memorial presented to the Viceroy, praying for the imposition of a cess, was signed on behalf of proprietors and companies representing rather more than 80 per cent. of the tea area under tea cultivation in North East India.

The Indian Tea Cess Committee is composed of twenty members representing the tea growers and the general commercial community.

The cess was levied at the rate of $\frac{1}{4}$ pie per lb. of tea exported (just over 2 annas per 100 lb.), and it remained at this rate till 1921-22 when at the instance of the industry it was raised to 4 annas per 100 lb. In 1923-24 the Act was amended, again at the instance of the industry, so as to enable the cess to be levied at the maximum rate of 8 annas per 100 lb. tea exported. The maximum rate has not been imposed so far, but in 1923-24 the levy was increased to 6 annas per 100 lb. of tea exported.

The cess is collected by the Customs Department and the proceeds are made over to the Cess Committee. An idea of the amount collected is given in the table below which shows the amount in the first year of the levying of the cess and in various other years.

	Rs.
1903-1904 at 2 as. per 100 lb. ...	2,66,894
1913-1914 „ 2 „ „ „ ...	3,75,616
1921-1922 „ 4 „ „ „ ...	7,44,334
1923-1924 „ 6 „ „ „ ...	12,66,123
1925-1926 „ 6 „ „ „ ...	12,28,526

At the time when the cess was instituted the Committee determined to concentrate their efforts largely on the United States of America. The work could not be carried on during the war, but in 1923 it was again taken up with vigour.

In continental Europe work started in 1905 in a small way in Belgium and Germany. The scheme steadily advanced till the outbreak of the war in 1914. Apart from gifts of tea to French and American troops little was done on the continent till 1925 when work began in France.

In the United Kingdom the Committee carried on an advertising scheme to counter the propaganda in favour of China tea. In the earlier years of the cess, contributions were made to a League formed with the object of bringing about a reduction in the duty on tea in the United Kingdom. Indian tea has also been represented at various exhibitions.

During the war, work was started in India on a large scale. No direct trading was undertaken by the Committee but funds were spent in encouraging the sale of tea by private enterprise. More than 40,000 bazar shop-keepers have been influenced to take up the sale of tea. According to statistics the sale of tea in India and Burma averaged approximately 18 million lb. annually for the quinquennium before the start of the propaganda work in India. During the year ended 31st March, 1926, the estimated quantity of tea available for consumption in India and Burma was over 50 million lb.

The Indian Tea Association has a well staffed and well equipped Scientific Department for investigating the various problems connected with tea culture and manufacture. The department was first started in a small way in 1900 following on a resolution passed at the annual general meeting of the Association in 1899. Immediately after that meeting the opinions of the branches of the Association were sought regarding the appointment of a scientist. The preponderance of opinion was distinctly in favour of the appointment of an agricultural chemist, and Mr. Harold H. Mann, B.Sc. (now D.Sc.), F.I.C., was

selected in London and engaged on a three years' agreement. The initial estimated expenditure of this appointment was reckoned at Rs. 1,500 monthly, which had to be met from the surplus funds of the Association, augmented by grants from the Government of Bengal and the then Administration of Assam, and from additional contributions from the different branches of the Association. The initial sanction for laboratory equipment was £200. The laboratory work was inaugurated in conjunction with the laboratory accommodation in the Economic Court of the Indian Museum, Calcutta, where laboratory accommodation is still enjoyed by this Association.

From these small beginnings the Scientific Department has developed into an institution employing a European qualified staff recruited from Home, consisting of a Chief Scientific Officer, three Chemists, an Entomologist, a Mycologist and a Bacteriologist, together with Indian assistants and others.

In 1926 the estimated expenditure of the department was Rs. 2,33,726 which is met by the money collected in subscriptions on an acreage basis from all tea companies in the membership of the Association.

Details concerning the work of the department are given later.

COMMUNICATIONS

It is no exaggeration to say that the development of Assam and the Dooars is wholly due to the tea industry. Communications have always presented a difficulty partly on account of unbridgeable rivers and partly because the tea areas are thinly populated.

Dibrugarh, the premier tea district, is 830 miles by railway from Calcutta the business head-quarters of the industry. The Terai, the district nearest Calcutta, is 340 miles from that centre. The main traffic artery of Assam was, until the beginning of

the present century, the Brahmaputra, and a service of paddle steamers plies between Calcutta and Dibrugarh, a distance of about 1,000 miles which is covered in a fortnight. The outlet for districts on the north bank of the river is still by steamer as far as Gauhati (Pandu).

In the Surma Valley, the Barak river was the main outlet before the railway was opened, and much tea is still brought by country boats to this river where it is transhipped to steamers.

The first railways in Assam were the Jorhat Provincial Railway, 2 ft. gauge, and the Dibru-Sadiya Railway, metre gauge, both built with the object of connecting tea districts with the Brahmaputra. The importance of the big river as a means of communication began to wane when the Assam Bengal Railway, metre gauge, was constructed from Chittagong to Tinsukia where it joined the Dibru-Sadiya Railway. This railway was built largely for strategic purposes and crossed the Barail range of hills from Cachar into the Assam Valley at Lunding. This outlet was an expensive one, for the railway crossed the hills at the geological fault between the Naga Hills and the Jainta Hills with the result that land slips were common and through traffic was often suspended.

In the meantime the line from Lunding to Gauhati had been constructed and an alternative route to Calcutta was by railway to Gauhati and then by river steamer to Dhubri, where the Eastern Bengal Railway was joined. The last link in the chain of communication between Calcutta and Assam was made when the line from Lalmanirhat to Amingaon, opposite Gauhati, was opened. During the last few years several important branch lines have been constructed in Assam.

The Dooars is served by the metre-gauge Bengal Dooars Railway which joins the Eastern Bengal at Lalmanirhat, where the line from Assam to Calcutta is joined. This line continues to Parbatipur where it joins the broad gauge line from Siliguri. Tea must be transhipped at Parbatipur. An alternative exit for

tea from the Dooars is *via* Dhubri on the Brahmaputra where the tea is transhipped to the river steamer and taken direct to Calcutta.

The Surma Valley is in direct railway communication with Chittagong. To get to Calcutta it is necessary to change at Chandpur and go by steamer to Goalundo whence the broad gauge section of the Eastern Bengal runs to Calcutta.

With the advent of motor traffic the need for good roads has become apparent, since most garden employ motor lorries and motor cars are used extensively by the planting community. The Assam Valley is particularly unfortunate so far as roads are concerned because very little suitable metal is available on the south bank, where most of the tea gardens are situated. The roads are accordingly of earth and are thick either in dust or mud according to the season. Many places are isolated in the rains except for bullock cart traffic.

In the Surma Valley some of the roads are better partly because laterite from the *teelas* is available and partly because much of the traffic is down the small rivers, thus reducing the cart traffic on the roads.

In the Dooars, road metal is plentiful and the roads are numerous and good all the year round. The trouble here is the rivers which cut the district transversely and are difficult or expensive to bridge.

So far as communications are concerned, both by road and railway, the Terai is the most favoured tea district in North East India. The railway centre is Siliguri whence the broad gauge runs direct to Calcutta.

Darjeeling suffers the inconveniences of transport which are unavoidable in a hilly district. In many cases the main trouble is to get the tea to the Darjeeling Himalayan Railway, a 2 ft. gauge line, which runs from Darjeeling at a height of about 7,000 feet to Siliguri in the plains where it joins the broad gauge to Calcutta.

STATISTICS

Practically all the black tea consumed comes from India, Ceylon, Java and China. Japan produces green tea which is unfermented and Formosa a distinctive tea, partly fermented, known as Oolong. China produces both green and black tea. No definite figures regarding the acreage under tea in China are available. The table below shows the approximate acreage under tea in the principal exporting countries.

	Acres.		
India	...	...	716,000
Ceylon	...	...	403,000
Java and Sumatra	...	...	250,000

The tea areas in the Dutch Indies are rapidly expanding, whilst the Ceylon acreage is almost stationary although about another 20,000 acres are available for tea. The Indian acreage is increasing steadily.

The tea area in India is made up as follows :—

	Acres.		
Assam	...	...	412,859
Bengal	...	...	181,833
Bihar and Orissa	...	...	2,099
United Provinces	...	...	6,119
Punjab	...	...	9,709
Madras	...	...	48,647
Tripura (Bengal)	...	...	4,793
Travancore	...	...	50,166

Total ... 716,225

The area in Assam and Bengal constitutes what is spoken of as tea in North East India. The small areas in Bihar and Orissa, the United Provinces and the Punjab are not organized as is the main area. The Travancore and Madras areas make up what is known as South India so far as tea is concerned.

The acreage in North East India is made up as shown below. Cachar and Sylhet are known collectively as the Surma Valley. The Brahmaputra Valley is that area of Assam east of Gauhati and is often spoken of as the Assam Valley. The district called the Dooars is officially known as Jalpaiguri and is situated at the foot of the Himalayas between the Teesta and the Sankos rivers. Darjeeling includes the Terai where about 20,000 acres are under tea. The Darjeeling District is the only elevated tea area in North East India, tea being planted up to heights above 6,000 feet, although the general altitude is 3,000 to 4,000 feet.

					Acreage	No. of Gardens
Brahmaputra Valley ...	...	...	...	...	268,105	586
Cachar ...	...	...	...	...	57,756	165
Sylhet ...	...	...	...	...	86,998	155
Dooars ...	...	...	...	...	117,576	132
Darjeeling and Terai	...	...	...	...	58,747	166
Chittagong	...	...	...	...	5,510	29
TOTAL ...					594,692	1,233

The total area in occupation by tea planters is 2,000,133 acres, much of the land given in grant being used for rice cultivation by the coolies on the garden and smaller area being given over to grazing and to forest grown mainly for fuel. In some districts practically the whole of the area under grant is opened out in tea, and here there is usually a difficulty in keeping coolies who regard a plot of land for rice cultivation as essential.

The growth of the area under tea is shown in the table below which gives the areas in Assam and Bengal.

Year					Assam acres	Bengal acres
Average 1885-1889	...	...	...	...	211,301	73,169
" 1900-1904	...	...	...	...	338,250	136,153
1914	...	...	...	...	376,375	159,304
1924	...	...	...	...	412,859	181,833

The total production of tea in North East India has increased at a greater rate than has the acreage because the output per acre has shown a steady general increase.

Year					Assam	Bengal
					lb.	lb.
Average	1885-1889	...	...	...	66,677,373	19,376,597
"	1900-1904	...	...	...	141,105,749	48,707,794
	1914	...	...	...	208,552,307	75,373,201
	1924	...	...	...	237,153,110	87,121,205

The total tea thus produced in North East India in 1924 was 324,274,315 lb., of which 1,178,744 lb. was green tea. The average production over the past ten years is 327 million lb., touching 350 million lb. in 1917 and falling to 242 million lb. in 1921, the slump year.

The tea is exported from Calcutta and Chittagong. In 1924-25 Calcutta dealt with 220,090,121 lb. and Chittagong with 79,656,694 lb. The difference between production and shipments is a measure of the amount of tea consumed within India.

That India is well maintaining her position in the tea world is shown by the table below. The figures illustrate the enormous increase in Indian export (these figures refer to all India) and the smaller, but still great, increase in Ceylon exports. Java, which only seriously entered the market in about 1900, has shown the greatest percentage increase, whilst China has shown a serious falling off. The figures in brackets show percentage changes.

Year	India	Ceylon	China	Java
	lb.	lb.	lb.	lb.
1896-97	150,421,245 (100)	110,095,194 (100)	240,106,266 (100)	
1905-06	216,770,366 (144)	171,256,703 (156)	152,936,800 (76)	25,650,156 (100)
1915-16	192,593,938 (194)	208,090,279 (189)	205,520,533 (86)	98,006,121 (382)
1924-25	348,476,011 (232)	204,931,217 (186)	102,124,666 (42)	105,113,200 (410)

The figures for China include black, green, brick and tablet tea and dust.

A study of the yield of tea per acre in both Assam and Bengal is instructive in that it illustrates the steady increase up till the end of 1919, followed by a drop. This is due to the post war slump when accumulated stocks of tea in England reduced the price of the current stocks of tea below the cost of production. After the slump the tea was in a poor state owing partly to the stoppage of manuring during the war years and lack of cultivation during the lean years following. The smaller irregularities in crop due to seasonal variation and pests and blights are masked by taking the five-year average.

Period					Assam	Bengal
					lb. per acre	lb. per acre
1885-89 ...	...	...	...	...	316	265
1890-94 ...	...	...	...	...	358	292
1895-99 ...	...	...	...	...	361	330
1900-04 ...	...	...	...	...	416	361
1905-09 ...	...	...	...	...	477	425
1910-14 ...	...	...	...	...	531	468
1915-19 ...	...	...	...	...	614	554
1920-24 ...	...	...	...	...	527	423

The averages suppress the yields from various districts of course. In 1924 the average yield in Assam was 576 lb. per acre and in Bengal 479 lb. per acre. The chief districts gave the following yields in that year :—

			lbs. per acre.
Lakhimpur (Dibrugarh)	...	...	752
Sibsagar	...	...	614
Darrang	...	...	576
Jalpaiguri (Dooars)	...	...	588
Darjeeling	...	...	330

Each district produces tea of some peculiar merit. Darjeeling teas sell largely on their flavour. Assam teas are valued for pungency and, at some periods of the year, for appearance. Dooars teas sell for strength and in the autumn for flavour. Cachar and Sylhet teas are generally inferior to those from other districts.

The average price of teas from the various districts sold in London in 1925 was as follows :—

				Average Price
				per lb.
Assam	...	...	...	17.93d.
Cachar and Sylhet	...	...	...	14.52d.
Darjeeling	...	...	...	19.02d.
Dooars	...	...	...	16.11d.

The tendency during the past few years has been for the prices of teas from the poorer districts like the Dooars and Cachar and Sylhet to approach those of Assam.

(To be continued.)

INDIAN TEA ASSOCIATION.

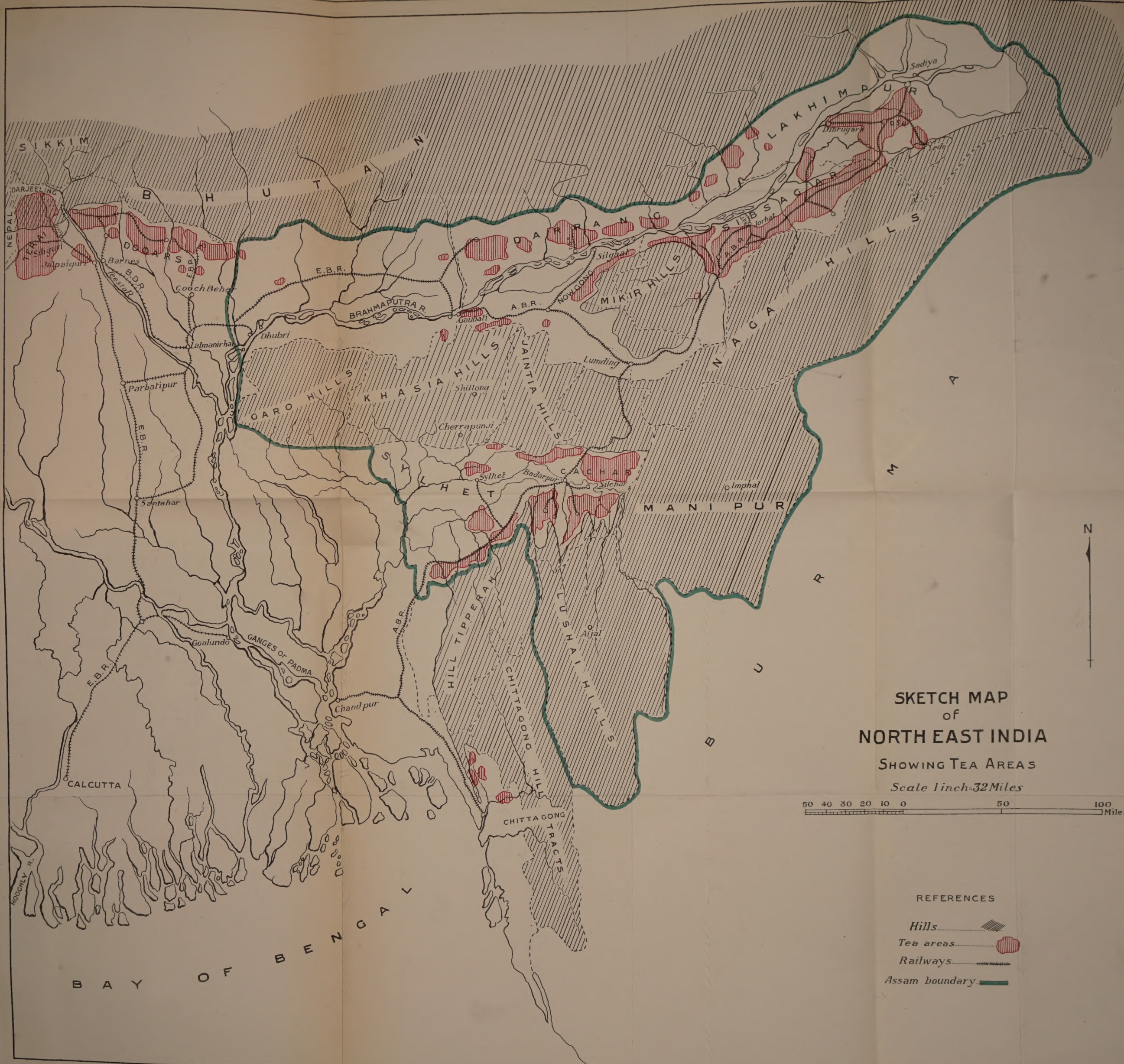
LIST OF QUARTERLY JOURNALS AVAILABLE FROM STOCK.

	Part I.	Part II.	Part III.	Part IV.	Price per copy. Rs. A. P
1911	Available.	Available.	Available.	Available.	0 6 0
1912	do.	do.	Out of Stock.	do.	0 6 0
1913	Out of Stock.	do.	Available.	Out of Stock.	0 6 0
1914	do.	do.	do.	Available.	0 6 0
1915	Available.	Out of Stock.	do.	do.	0 6 0
1916	Out of Stock.	Available	Out of Stock.	Out of Stock.	0 6 0
1917†	do.	do.	do.	Available.	0 6 0
1918	do.	Out of Stock.	Available.	Out of Stock.	0 6 0
1919	Available.	Available.	do.	Available.	0 6 0
1920	Out of Stock.	Out of Stock.	Out of Stock.	Out of Stock.	0 6 0
1921	Available.	Available.	Available.	Available.	0 8 0
1922	do.	do.	do.	do.	0 12 0
1923	do.	do.	do.	do.	0 12 0
1924	do.	do.	do.	do.	0 12 0
1925	do.	Out of Stock.	do.	do.	0 12 0
1926	do.	Available.	do.	do.	0 12 0
1927	do.	Out of Stock.	do.	Out of Stock.	0 12 0
1928	do.	Available.	do.	Available.	0 12 0
1929	do.	do.	...	...	0 12 0

†Bound volume for 1917 is available.

Copies of the above, except those, which are out of stock, may be had from the Secretary, Indian Tea Association, Calcutta. (Post box 280.)

Corrected up to 31st July 1929.



SKETCH MAP
of
NORTH EAST INDIA

SHOWING TEA AREAS

Scale 1 inch = 32 Miles

50 40 30 20 10 0 50 100 Miles

REFERENCES

- Hills.....
- Tea areas.....
- Railways.....
- Assam boundary.....

